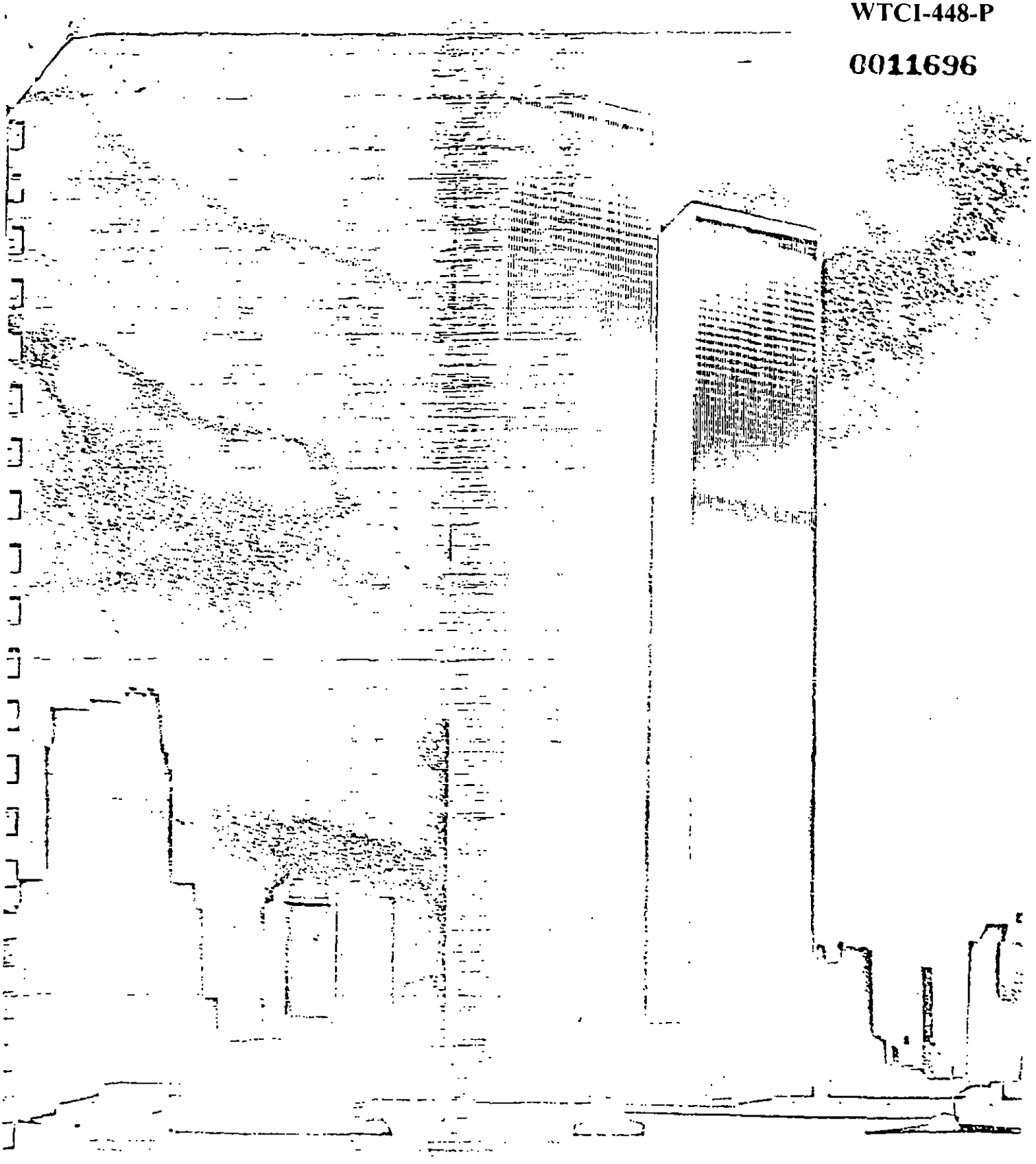

A presentation by Aluminum Company of America documenting its proposal for participation in the wall construction of World Trade Center. December, 1966.

PA LAW DEPARTMENT
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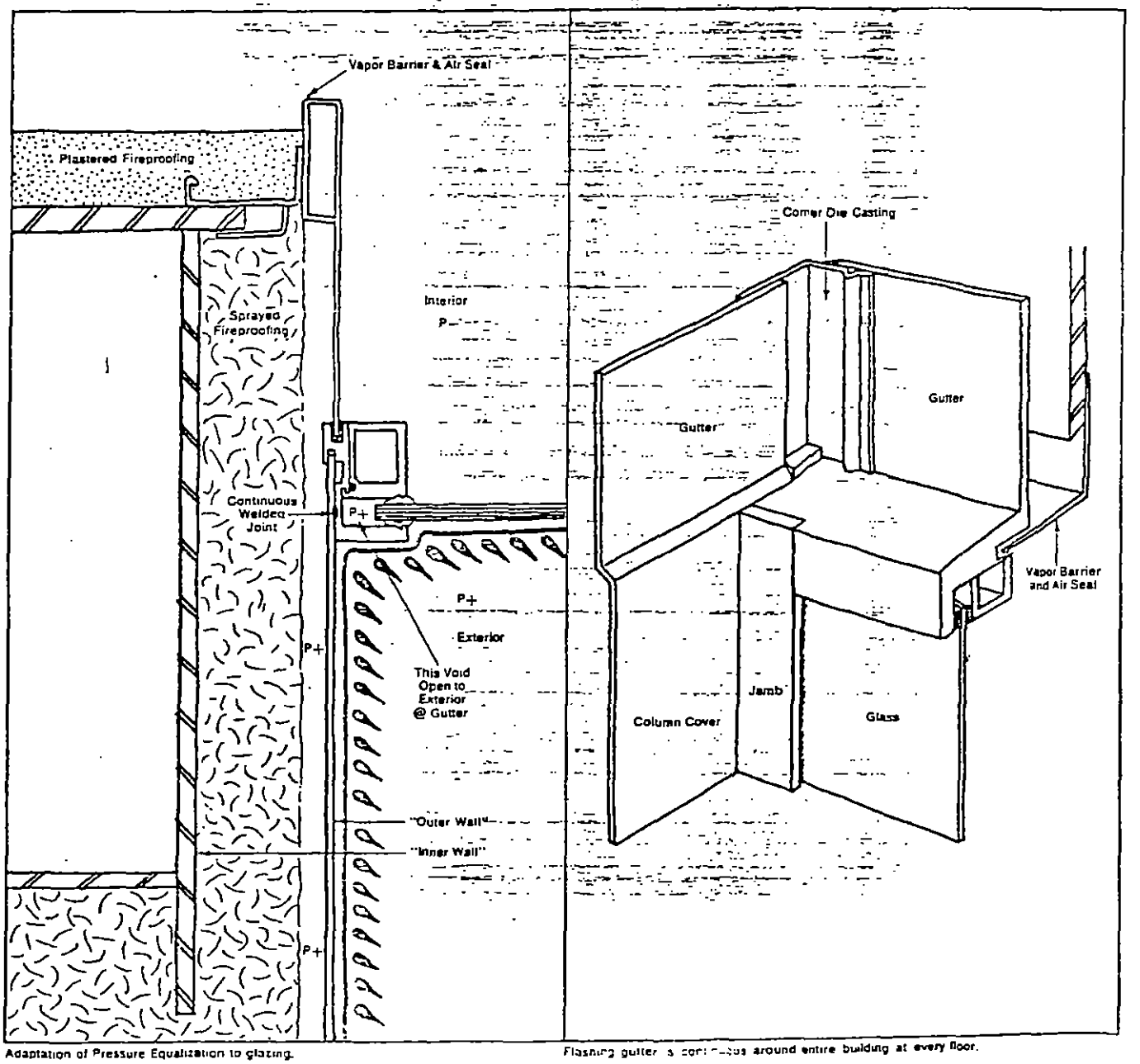
wall which is designed with as few openings as possible. Thus air infiltration is minimized and there is no water present at the inner wall to be carried to the building interior by such minor infiltration as may exist.

In this proposed wall system for World Trade Center, the aluminum curtain wall is considered the outer weathering wall while the steel structure acts as the inner pressure resisting wall.

Glazing, of course, is not a double wall but is in itself an impervious membrane. It remains only to pressure equalize the glazing seal and carry the seal to the inner wall as illustrated.




Adaptation of Pressure Equalization to glazing.

Flashing gutter is continuous around entire building at every floor.

## THERMAL INSULATION

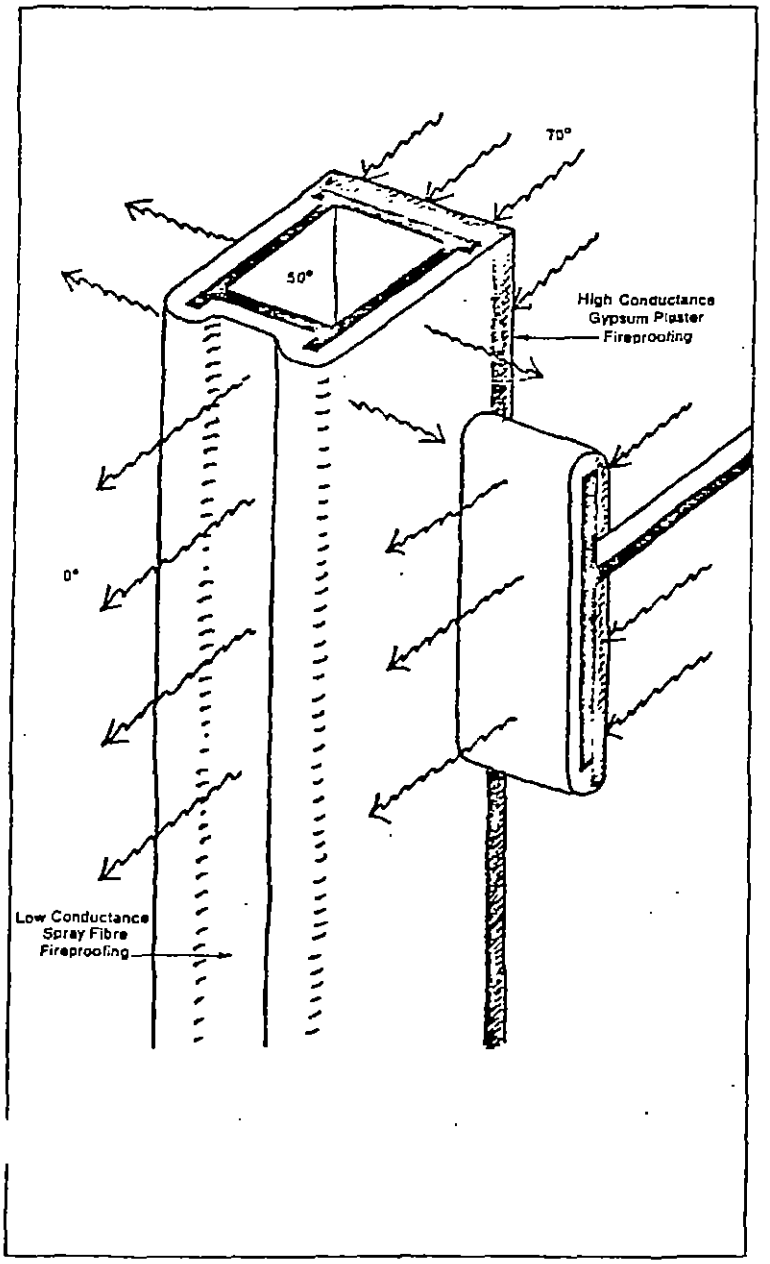
The insulation materials applied to the structural steel components of the wall (columns and spandrels) must serve to control column temperature to a minimum of 50° with 70° inside and 0° outside, provide fireproofing to meet a four hour test on a heavy column, and minimize heat loss and gain to satisfy HVAC requirements. After extensive testing of many insulating and fireproofing materials, a sprayed mineral fibre has been selected to meet all requirements of the three purposes above. It will be used on the three exterior sides of the column and both sides of the spandrel plate. The *room* side of the column will be covered with gypsum plaster to meet fireproofing requirements with a relatively high "K" value to permit heat migration to the steel. This migration is necessary to hold steel temperatures above specified minimum during extreme and prolonged cold periods.

**Thermal Testing**

The minimum column steel temperatures of 50°F requires strategic use of both high "K" and low "K" fireproofing. Since the required thermal balance results from a combination of many factors, calculations can be only a rough guide to design and true performance can be determined only by actual test.

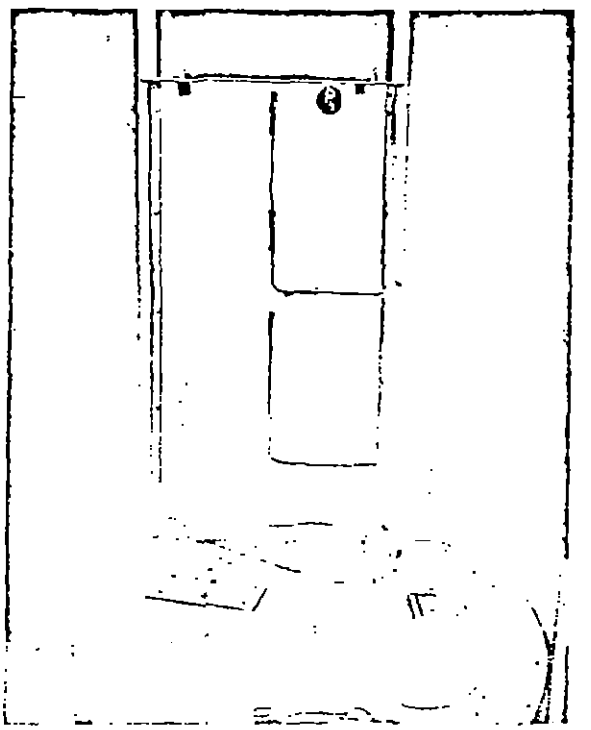
Such tests have been performed at Cupples on three 5' sections of columns completed in full detail typical of the 100th floor. Two units were assembled in a dividing partition of the thermal chamber at Cupples with thermocouples mounted on the steel, top and bottom and inside to outside. "Outside" temperature on one side of the partition was reduced to 0°F and "Inside" temperature was controlled at 70°F until steel had reached thermal balance when results were recorded. A third unit was tested similarly at Pennsylvania State University in the thermal chambers of the Institute for Building Research.

Complete details of tests and results are included in the pocket at the back of this book.




Heat Flow Characteristics of column, spandrel and fireproofing.

Thermal tests in progress in test facilities at Cupples Division.



Thermal tests in progress at the Institute for Building Research, Pennsylvania State University

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## ERFORMANCE OF ATERIALS

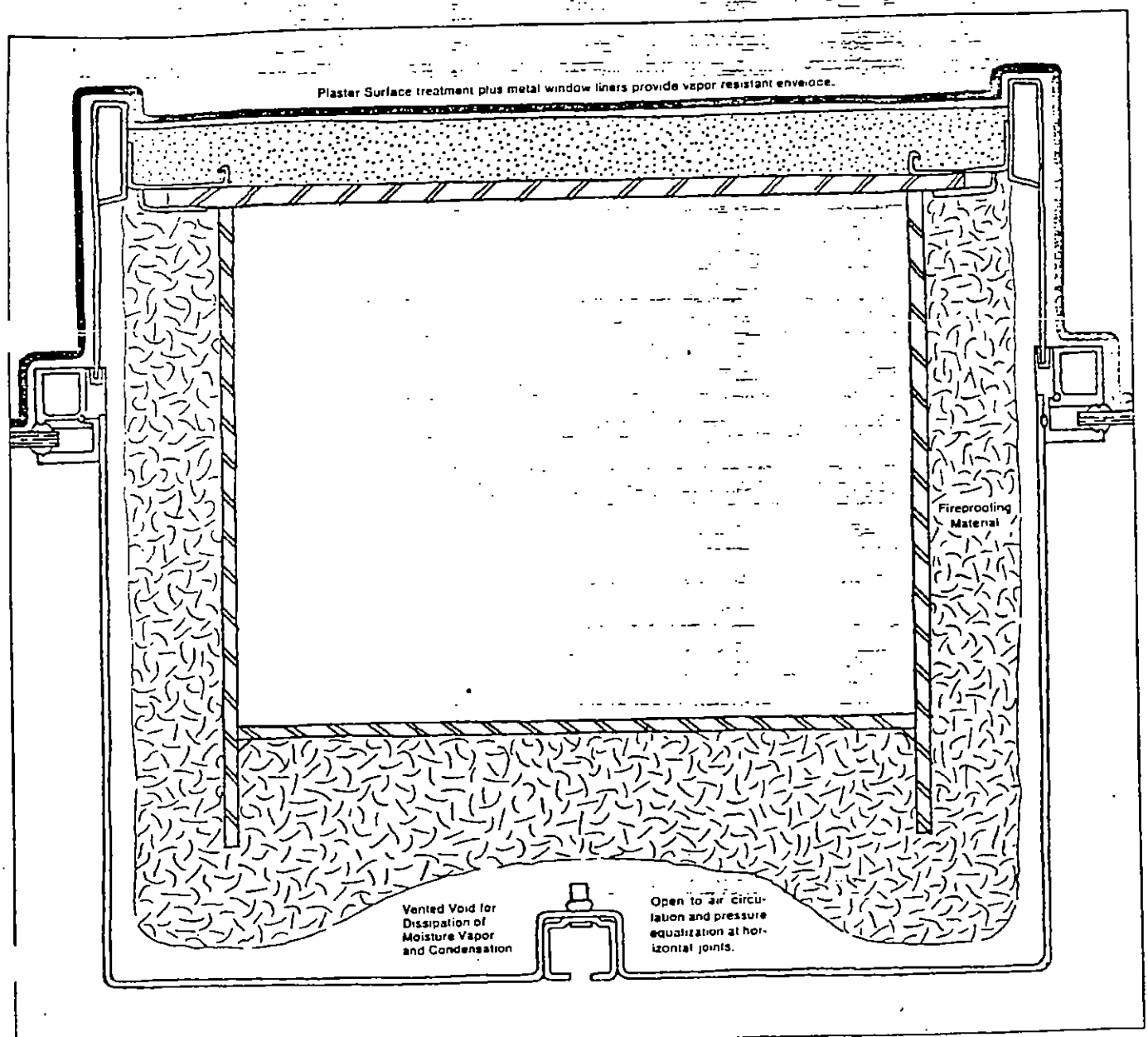
Ability to withstand severe weath- been proven over four decades of and application experience in the industry.

various finishing techniques proposed architectural exteriors enhance further the tal's natural weathering resistance. Expo- ure to weather is discussed in the pamphlet, "Weathering of Aluminum," provided in the back pocket of this book.

**Fireproofing materials** can deteriorate with trapped moisture, particularly under freeze and thaw cycles. A vapor barrier on the warm side of the wall coupled with free breathing to a vented void on the cold side is the performance—documented engineered safeguard against damage from unvented vapor transfer, weather change condensation and existence of any minor leaks or siphonage.

**"Poultice Corrosion"** of metals can occur under intimate long term contact with moisture laden materials markedly acidic or alkaline in character. While the contacting surfaces can be protected by several techniques, logical engineering faces the metal on the same vented void discussed above rather than in contact with absorbent fireproofing.

**Dissimilar metal contact** is always worthy of design consideration as a possible corrosion hazard. However, 300 series stainless steel is a film forming material and is quite compatible with aluminum. As the window washer track, it needs only minimum precaution to prevent trouble under the most severe circumstances.




Horizontal Column Section to show relationship of the vapor resistant envelope to the vented void which also separates the "inner" wall from the "outer" wall to accomplish pressure equalization.

**Hoisting**—All hoisting would be done after regular working hours from 4 P.M. to approximately 8 P.M. Assuming the inside dimension of the hoist platform to be 7'4" x 13'3", each lift will include one mobile cart carrying two 1800# packages.

**Distribution and Floor Storage**—On the designated floor the mobile carts would be moved to storage areas allotted for the purpose. A minimum of six and as many as ten floors of material would be so stored ahead of the actual erection. Glass would be handled on the inside job hoist in cases weighing 3,600 lb. The cases would be handled, moved and stored on the floors in the same manner as the metal components.

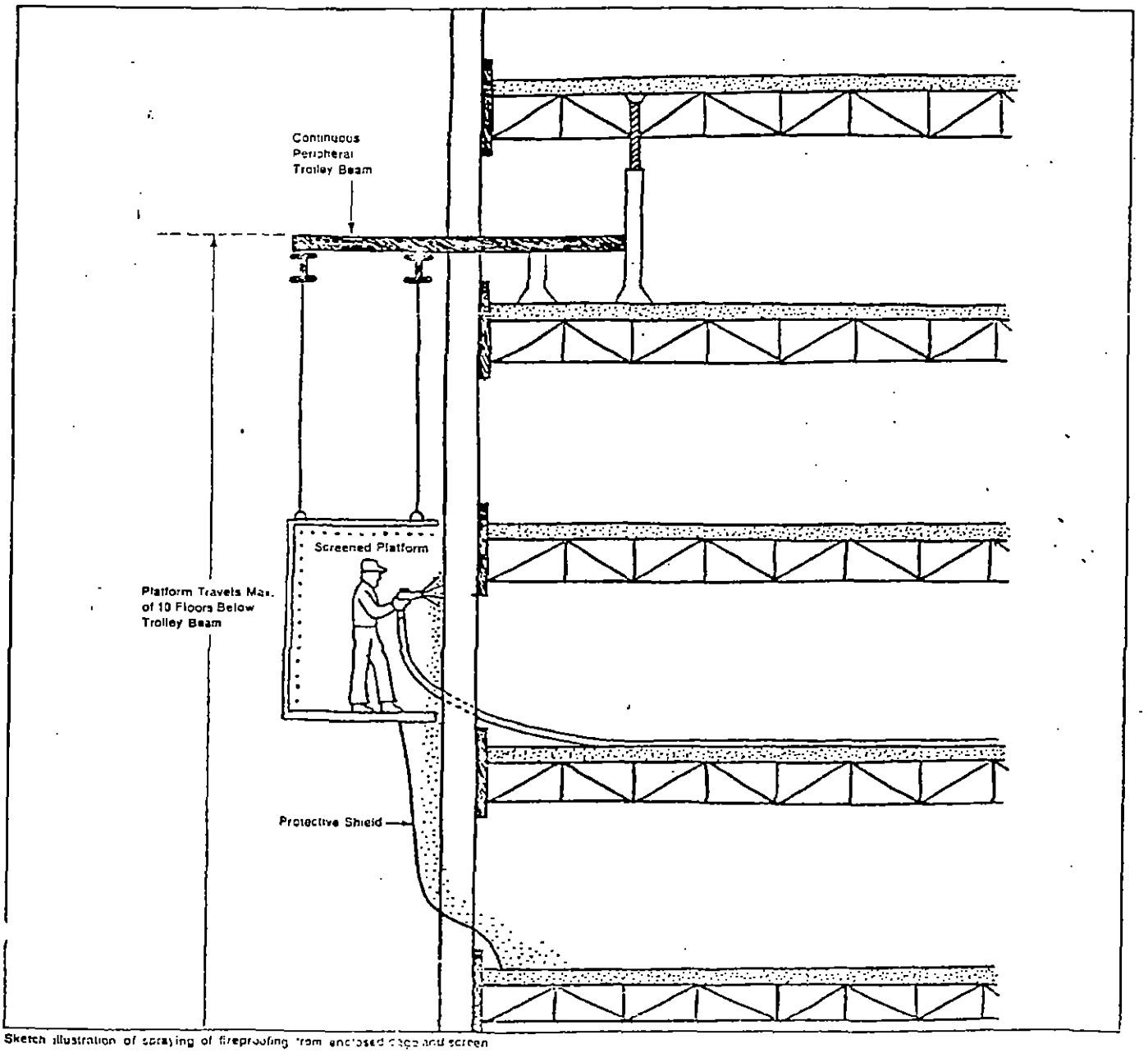
## FIREPROOFING

Sprayed fiber material as manufactured by CAFCO and of a type described in Underwriters Laboratories report R 3749-10 will be applied to three sides of the exterior columns thick enough to provide four hour fire protection and to maintain the proper thermal insulations. The required thicknesses to meet fireproofing requirements are 1 7/16" for exterior columns and ½" for spandrels. As space permits, the thickness can be increased to obtain the required thermal characteristics.

On the inner side of the columns, a high "K" value material will be applied to provide fireproofing while also permitting heat migration from room air to column steel.

The sprayed fiber will resist the elements during construction of the curtain wall, remain firm to the touch and will not reduce in thickness with time. (See copy of CAFCO Bulletin C-940 in pocket at rear of book). Application would be accomplished with a special nozzle and a transportable cage to safely project the applicator to the exterior of the building. Adjustable vertically, the cage would permit complete coverage of the outer faces of columns and spandrel beams. A screen would be provided around the spray zone to prevent the "blow-by" of fiber material to the exterior of the building and the street below.

Fireproofing in progress would be approximately ten floors above the aluminum wall,




Sketch illustration of spraying of fireproofing from enclosed cage and screen

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spraying at the rate of two floors per day and using a crew of 30 men and 16 machines. Hoisting of materials, done at night, would require 2½ hrs. per floor to move 1,250 bags of material per floor. Unloading would be at the rate of two trucks per floor direct to the hoist. The contractor would provide water and electric power to each floor.

## METAL AND GLASS ERECTION PROCEDURES

A time table for the various divisions of work follows:

Concrete—five floors below steel
Anchors—six floors below concrete
Fireproofing—six floors below anchors
Metal Wall—ten floors below fireproofing

The entire curtain wall structure is supported on adjustable master mounting anchors secured by bolts to the spandrel beam. This permits nesting the covers to the fireproofed columns without the interference that column mounted fasteners would present. A wheeled dolly with automatic equipment mounted will drill the beam from the floor in locations predetermined by layout. Anchors would be bolted from the floor. Column covers would be removed from the floor storage packages and handled by means of a fork lift truck with a special remote control arm which clamps to the column cover, projects it through the column opening, rotates it to vertical position, and backs it into place around the column while attachment is accomplished.

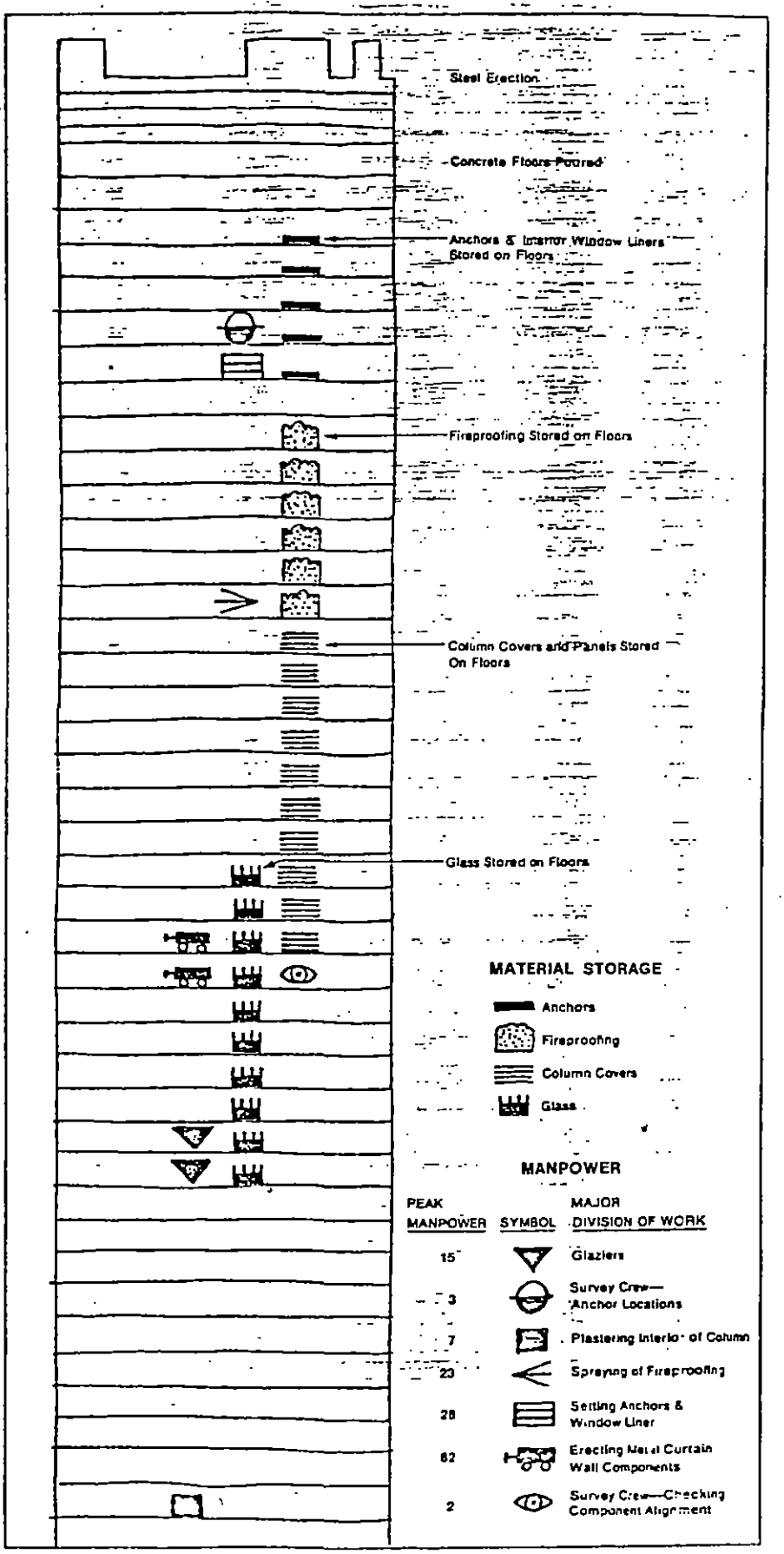
A separate crew would set the spandrel panels and glazing frames. A survey crew will check position of completed units by instrument before final tightening of fasteners.

Installation of glass would progress about six floors behind the completed metal installation. Glass would be set entirely from the inside using neoprene glazing materials adapted to the pressure equalization principle.

With this curtain wall design, units can be set floor by floor, elevation by elevation, or portions of elevations allowing great latitude in building construction.

## MANPOWER

At two floors per week, the installation of metal would require approximately 95 mechanics and foremen. An additional eight men would be needed as supervisors, timekeepers, material checkers, etc. Normally, eight men would be working after 4 P.M. unloading and hoisting. A two-man survey crew would lay out work for anchors and check the positions of completed work. Approximately (15) glaziers can maintain the rate of two floors per week. Erection procedures would require approximately 450 amps at 220 volts located at six floor intervals.

A graphic presentation of sequence of erection, manpower distribution, and materials storage is shown at right.

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